Preparing for Future Warfare with Advanced Technologies

Prioritizing the Next Generation of Capabilities

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A new era in military planning is under way, which has involved some dramatic changes so far. As the defense leadership attempts to define and prepare a more efficient and effective military from the top down, the services are selectively transforming key capabilities to meet the anticipated needs for warfare in the new millennium. This broad-level change is continuing at a faster pace than some might have expected, with both derivative and entirely new capabilities becoming available. The challenges in this era are remarkably different from those planners confronted in the past.

In the previous era, the primacy of planning involved countering the single major threat to national security. In that era, the questions of the "who" and the "where" were known, and the challenge was less about understanding the problem and, perhaps, more about providing the solution. Then, the answer appeared to be linked to developing a superior military capability by way of manpower and materiel that would in large part already be in place. Where parity in manpower could not be achieved, technology was implemented to level the playing field. Here, many "force multipliers" were designed and fielded, including the first generation of truly "smart" and precision-guided weapons. All the services collectively did their part, resulting in a highly effective military—their success in combat being showcased in the Persian Gulf War.

But in this new era of planning, many things have changed. In dramatic contrast to the previous era, the immediate challenge is about understanding the problem, not just the "who" and the "where," but also the "why" and "to what extent," at a time when a solution is seen by others as already overdue. In

some sense, the critical challenge *is* less about providing manpower and materiel *en masse* and more about providing the right combination, as defense spending remains a key constraining factor. Because of the previous era's investment in research and development, the residual momentum is providing today's defense policymakers with choices for building the next generation of capabilities. Thus, one fundamental question among many others now being asked is, "What capabilities are essential for the future, and how should they be prioritized?"

This issue paper seeks to address this question, bringing to bear empirical analysis based on sophisticated modeling and simulation recently carried out by RAND researchers. In particular, using a scenario based on experiences in Operation Allied Force in Kosovo in 1999, researchers evaluate how three prioritizations of capabilities might play out in a similar small-scale contingency (SSC) in the 2015 timeframe. The evaluation assesses how well the three prioritizations meet what is argued below are some new measures for achieving success in warfare.

How Is Success in Warfare Currently Measured?

Though many in the defense community might readily agree that the needs are indeed considerably different from what they were in the past, defense planners are finding it hard to get beyond the measure of success used in the Cold War—halting a massed armor invasion. Perhaps this inability to get beyond the past is driven by the need for some solution, any solution, amid the ongoing uncertainty planners currently face. For example, the two major theater wars (MTWs) in current defense

planning involve enemy and friendly forces beginning in close proximity. In Kosovo, Operation Allied Force began with Serbian paramilitary forces already in place, with friendly and unfriendly noncombatants interspersed. Numerous other recent SSCs have presented similar dilemmas. And there are cases of mission creep in humanitarian operations that go astray. If the past decade of global conflict serves as any kind of signpost of things to come, the list of challenges the U.S. military will face in accomplishing future missions will become considerably more complicated. In particular, the lines between friendly and enemy forces and success and failure will blur. In some sense, perhaps the basic equation for defining success in warfare is changing. In the past, the equation might have been as simple as

success = accomplishment of objectives,

where accomplishing the objectives relies on bringing to bear some measure of coercive or compelling force on the enemy at the operational level or below, should deterrence fail. Of course, additional humanitarian factors would be considered to some extent, but attaining the objectives would be paramount.

However, how success is measured in warfare may be changing or, some might argue, has changed already. The new equation for success may look something like the following:

success = accomplishment of objectives, given that friendly losses are kept to a minimum and noncombatant casualties and collateral damage[1] *are acceptable.*

In this case, success would still require bringing coercive or compelling force to bear on the enemy at the operational level and below to accomplish objectives,

but the mission may have to satisfy the additional conditions. While such conditions have always been implicitly present in military engagements, they are seemingly becoming an explicit part of today's—and tomorrow's military endeavors; as such, meeting these conditions makes it all the more difficult for the DoD to succeed in warfare.

How Can Future Capabilities Be Prioritized?

In examining capabilities for the future, we explored three broad prioritizations of capabilities, driven by future technology options: (1) remote fires, (2) rapidly deployable ground forces, and (3) a joint capability that integrates the two. In each of the prioritizations, we assumed improvements to U.S. forces consistent with what we might expect to become available in the 2015 timeframe.

Improvements for the Remote-Fires Option

What can we expect with advances in technology? First, programmed advances in command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) will provide greater levels of situational awareness to friendly forces and will offer the potential to improve knowledge of enemy actions. Second, smart munitions will become smarter. The advent of automatic target recognition (ATR), coupled with smaller, higher-resolution sensors and processors, will allow weapons to be dispersed over an area. Second-generation smart weapons such as the Army's brilliant anti-tank (BAT) submunition and the Air Force's low-cost autonomous attack submunition

(LOCAAS) can be dispensed over an area of the battlefield and independently search for potential targets. Third, guided munitions will become more accurate. For example, the direct attack munitions affordable seeker (DAMASK) effort mated to a joint direct attack munition (JDAM) is advertised to achieve a three-meter circular error probable (CEP). Lastly, standoff ranges can be increased dramatically; in this scenario, weapons can be launched outside the envelope of enemy air defenses.

Improvements for the Rapidly Deploying Ground Forces Option

Between now and 2015, we expect the Army to undergo its planned transformation. This will yield medium-weight forces in the form of the Interim and Objective Forces envisioned to dramatically improve the nation's ability to project power by supplying rapidly deployable ground force components.

Two major factors distinguish the Interim and Objective Forces from current forces: improved deployability and greater effectiveness. Initial estimates using the table of organization and equipment for the Interim Force suggest that medium-weight units will be roughly half the weight of comparably sized heavy armor and mechanized units.[2] Initial results from the digital brigade exercises at the National Training Center (NTC) have shown that new concepts incorporating greater dispersion, increased area of coverage, and more lethal effects are possible through digitization and improved situational awareness.[3] Of course, in some situations, such as a maneuver operation in the desert, heavy forces would be preferred to medium-weight forces. In general, though, medium-weight units should be able to

occupy a greater battlespace and, with their networked operations, mass effects rather than forces. If this capability continues to develop, the combined results can offer dramatic improvements in force effectiveness.

A Combined Approach, Through a Joint Rapidly Responsive Force

What might the difference be if a joint approach was used? Over the past several years, there has been increasing momentum for constructing a truly joint capability with greater integration, which is now articulated in the Joint Chiefs of Staff document Joint Vision 2020. While different force options are still being examined by Joint Forces Command, some concepts, such as Joint Rapid Decisive Operations, have emerged and are being explored through experimentation. By combining the first two capabilities, it is possible to leverage each one's areas of strength and minimize areas of weakness.

What Happens When the Various Options Are Analyzed?

Starting with the foundation of what actually happened in Operation Allied Force, we used combat simulation to help answer the question of what the best option might be—in terms of the measures of success discussed above—if the United States chose to enter into a notional conflict in the Kosovo setting many years from now (in the 2015 timeframe). We based the threat in our scenario on the Serbian military structure and organization in 1999, with the capability somewhat modernized to reflect an improvement to sensors and weapons.

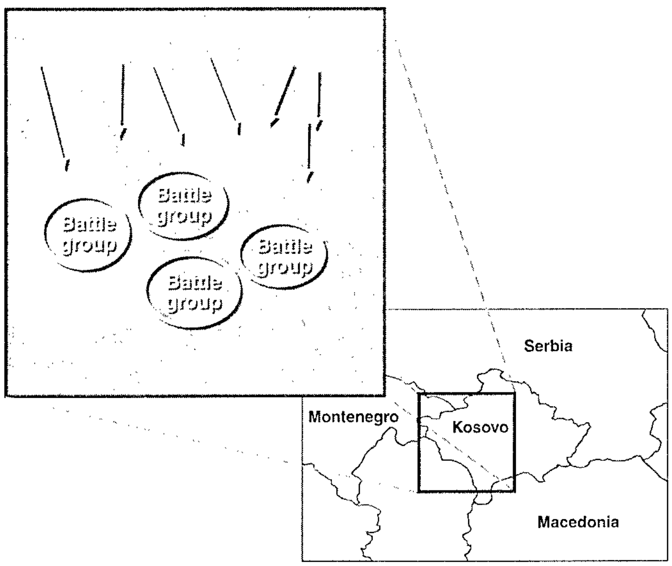

Figure 1. Kosovo Scenario: Four Battle Groups in Place, Seven en Route

We used high-resolution simulation to explore the different attack options.[4] This scenario is set in the 2015 timeframe, and we assume that four enemy battle groups (reinforced companies) are in theater committing atrocities and seven more are en route to reinforce the four already in-country.[5] The U.S. objective is to stop the atrocities and halt the enemy flow into theater, shown in Figure 1. In doing so, we consider the three engagement options.

We look at the results of the simulation for each option separately, beginning with the remote-fires option. The overall process involves starting with advanced C4ISR and remote weapons, then adds improved target recognition to the long-range fires, compares this to aground force application of force, and then finishes with a combined approach.

Remote-Fires Option

Table 1 summarizes the effectiveness of the remote-fires option across the criteria for a successful operation discussed above. At the fundamental level of success—accomplishing the military objectives of halting atrocities and mass genocide—the remote-fires option is not much more successful than it was in 1999, because the advanced technology, particularly in C4ISR coupled with remote fires, does not address the limitations that did and still do exist. While greater attrition of vehicles is possible, and advancements in technology allows more targets in the open to be engaged, the basic problems of engaging mobile, tactical targets from afar will not change markedly.

In terms of the C4ISR capabilities, the future battlefield turns out not to be as transparent as believed. While advances in C4ISR can provide more situational awareness of friendly forces and can improve knowledge of enemy actions, comprehensive situation understanding does not appear to be feasible in this timeframe. Enemy forces that operate under foliage, perhaps dug in under earth (as was the case

Table 1. Effectiveness of Options: Remote Fires

Measures of Success/Options	Remote Fires
Accomplish objectives	No
Loss-exchange ratio (Red/Blue Losses)	N/A*
Loss of friendly forces	None
Loss of noncombatants	~4,000

*No ratio because no friendly losses were assumed with the application of remote fires; achieves 325 Red losses in the best case, 48 Red losses in a more traditional application.

in Vietnam), will be particularly difficult to detect and identify. In particular, remote (overhead and medium-to-high-altitude) assets appear to be approaching limits because of physical constraints of wavelength, resolution, and information fusion. More relevant, as remote assets become more capable, it is likely that a future foe will develop counter technologies and become more sophisticated at cover, concealment, deception, and electronic warfare. *Taking all of these into consideration, the net effect may actually be a decrease of knowledge and ultimately of situational awareness on the battlefield.*

As for remote, precision-guided munitions, they do not revolutionize the battlefield. In Kosovo in 1999, the ability of remote weapons to influence the "tactical" part of the battle was limited at best. Looking forward 15 years, with advances in airpower-based concepts and technologies, we find only modest change in the context of a Balkan scenario. For example, more accurate weapons that do not rely on seekers for target engagement (e.g., the 250-pound small smart bomb) offer greater efficiency than those in the inventory today and can attack through foliage. However, they do not resolve the fundamental problem at hand: the ability to selectively attack enemy forces that may be intermixed among noncombatants. As a result, even an idealized application of C4ISR and remote firepower does not work in this scenario: it cannot control territory, protect populations, and stop the inflow of additional enemy forces.

Despite the advent of information technologies, the type of "clean" war resulting here may simply be a scaled-down version of attrition warfare, but with more advanced technologies. As was true in 1999, the remote-fires option may make it possible to min-

imize losses to friendly forces by keeping them perhaps even farther out of harm's way.[6] However, this has the potential to hold noncombatants at risk. Using estimates of displaced Albanians in the early stages of the conflict (March–April 1999), we calculated the number of casualties that might be expected from attacking Serb targets in woods and moving on roads and other open areas.[7] Densities of civilian populations ranged from as little as 15 per square kilometer in the countryside to as high as 1,500 per square kilometer in urban areas. Under these assumptions, an aggressive remote-firepower campaign can result in roughly 10 times the number of noncombatant casualties for every enemy attrited, or, as shown in the table, about 4,000 such casualties.[8]

Rapidly Deploying Ground Force Option

As a baseline, we assumed that a medium-weight force, based on future combat systems (FCS) capabilities,[9] was used as the main response to counter Serbian forces in the scenario. The basic principle here is that by using such a rapidly deployable ground force, a relatively small conflict can be contained and possibly resolved. At minimum, such a force would be able to set the conditions for a larger follow-on force if necessary.

The resulting force accomplished the objectives of the mission, but did so with some friendly force casualties.[10] The results are shown in Table 2, which builds on the earlier table. While many cases were explored, Table 2 shows the results for the excursion that involved an FCS-based force equipped with an active protection system (APS), robotic vehicles, advanced fire control, improved tactical sensors,

Table 2. Effectiveness of Options: Rapidly Deploying Ground Force

Measures of Success/Options	Remote Fires	Rapidly Deploying Ground Force
Accomplish objectives	No	Yes
Loss-exchange ratio (Red/Blue losses)	N/A*	7.9 237/30**
Loss of friendly forces	No	Yes (30)
Loss of noncombatants	~4,000	Limited***

*No ratio because no friendly losses were assumed with the application of remote fires; achieves 325 Red losses in the best case, 48 Red losses in a more traditional application.

**Best-case scenario, with added technologies and with vertical envelopment. Without deep maneuver enabled through use of the FTR (or fast ground movement), a more traditional but dispersed frontal attack resulted in a loss-exchange ratio of 2.5.

***Because of very tight rules of engagement and combined precision-guided weapons, very few noncombatant losses were assumed during engagements.

advanced organic precision-guided weapons, and advanced operational deployability.[11] These enhancements allowed the force to achieve the mission. As the table shows, in this scenario there are still friendly force losses, but because of the tight sensing and targeting linkage, there are limited noncombatant losses.[12] A primary advantage of this option is the decisiveness of close combat. A ground force that "closes" with the enemy (even if many of the fires are organic indirect fire) can win in short order, whereas long-range standoff fires tend to pick away at the enemy for long periods.

The Joint Forces Option

The expected dramatic improvement in deployability that is envisioned by the medium-weight ground force can eventually change the way the commanders in chief (CINCs) and defense planners envision the role of ground forces in future combat in major theater war, small-scale contingencies, and operations

other than war. It is likely that such medium-weight forces would be used as an integral ground component of a joint rapid-reaction force, which conceivably could be deployed anywhere within days, provided an adequate airlift plan is structured.

Table 3 shows the results of a joint force option that fully accomplishes the mission. The loss-exchange ratio (LER) nearly doubles, reflecting both higher Red force losses and lower Blue force losses. This occurs because combining remote fires and rapidly deploying ground forces offers significantly greater lethality. Better protection provided more time for acquisition and engagement, and better local or organic indirect-fire weapons with short timelines reduced the intensity level of the close battle. Thus, new concepts would be integrated that would minimize direct contact with certain classes of enemy. In cases where remote fires (delivered from long-range missiles or tactical aircraft) would be effective, such capability would be used; in other cases, where shorter timelines are necessary for a successful engagement or weather conditions preclude air operations, organic indirect fires would be used.

Table 3. Effectiveness of Options: Joint Forces

Measures of Success/Options	Remote Fires	Rapidly Deploying Ground Force	Joint Force
Accomplish objectives	No	Yes	Yes
Loss-exchange ratio (Red/Blue losses)	N/A*	7.9 237/30**	13.3 333/25**
Loss of friendly forces	No	Yes (30)	Yes (25)
Loss of noncombatants	~4,000	Limited***	~1,400

*No ratio because no friendly losses; achieves from 48 to 325 Red losses depending on assumptions.

**Best-case scenario with added technologies and with vertical envelopment. A more traditional but dispersed frontal attack resulted in a loss-exchange ratio of 4.9.

***Because of very tight rules of engagement and combined precision-guided weapons, very few noncombatant losses were assumed during ground engagements.

Other forms of synergy between remote fires and ground forces are also expected but were not modeled in our simulation. These include positioning of ground forces to make an enemy mass outside cover, making them more vulnerable to remote-fire engagements. The ground forces can potentially "clean out" man-portable air defense systems (MANPADS) and other air defense systems along key corridors. Both of these tactics should improve remote-fire effectiveness.

Despite a focused effort to defeat a foe with combined remote and organic indirect fires, some direct contact with enemy forces is likely if not inevitable, even with a highly advanced joint-force capability. Here, extensive use of information technologies, robotics technologies, weapons technologies, and protection technologies (e.g., APS), in conjunction with new concepts, can help mitigate the effects of this kind of battle.

The one clear downside to the joint force option is that bringing remote fires back into the equation once again leads to the loss of noncombatants. Since there is a balance here between remote fires and ground forces, the noncombatant casualties drop by about two-thirds over the pure remote-fires case. Still, the casualties are substantial.

Looking across the options, it is clear that given either the old or emerging equation of success, an option that relies on remote fires alone to conduct the mission is of limited utility. Since this option has only a single dimension of attack, it has limited applicability to begin with and further can open up the opportunity for an enemy to focus his countermeasures exclusively in this area. The end result may be a lack of direct coercive or compelling force. If the mission cannot be accomplished at this level, policymak-

ers may face poor options in accomplishing it at all. They may be forced to either shift to the strategic level and bomb military-related targets in cities or seek (or bargain for) a political solution. Additionally, this option opens up issues of noncombatant casualties (and the public perception thereof) and encourages the enemy to leverage those issues by deliberately using noncombatants (e.g., as shields) for military purposes.

It is also clear that in satisfying the equation of success, policymakers may face a tradeoff between losing more friendly forces and causing more noncombatant losses: using remote fires may save friendly forces, but it may do so at the expense of noncombatant losses. As the spectrum for conflict continues to be debated, Figure 2 helps to illustrate the degree to which remote fires and ground forces provide coercive or compelling force. Clearly, both kinds of capabilities are

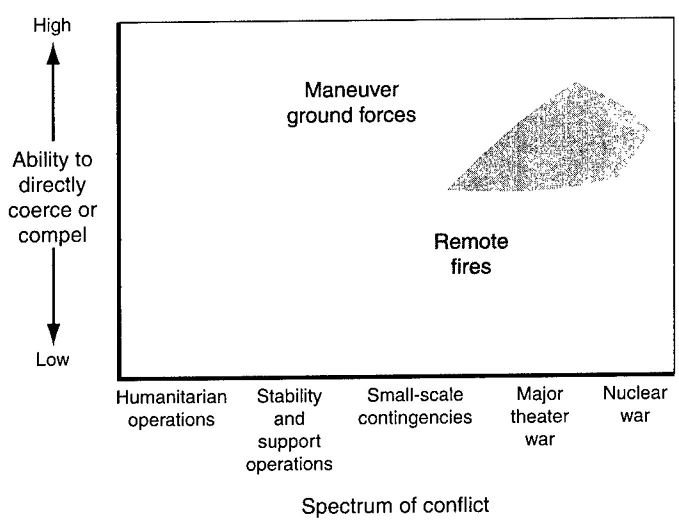

Figure 2. Coverage of the Basic Spectrum of Conflict by Ground Forces and Remote Fires

desirable. Remote fires may be an essential capability for strategic deterrence and large-scale conflicts where weapons of mass destruction are employed. At the other end of the scale, dismounted infantry will be required to conduct humanitarian and stability and support operations (SASO). In between, remote fires and ground forces can work together in the battle. Historical examinations and analytical studies have shown that in either the offense or defense, a land force is the decisive element in combat; this can be markedly enhanced when such a force is interleaved with other joint remote-fires capabilities.[13]

Conclusions

Although U.S. forces are currently prepositioned in various locations around the globe, there is no guarantee that they will remain in place. Perhaps even more relevant, there is no assurance that these locations will be the ones where war is most likely to break out, or that they will align with national strategy or interests, particularly as the world and national priorities continue to shift. As the world's economies and militaries and balances of power continue to change and as the criteria evolve for U.S. military intervention, the uncertainty increases. All this builds a case for having a capable and strategically mobile force that "can go anywhere" and address a "full spectrum of operations." Building a rapid-response joint force appears to offer the beginnings of a solution.

Although the research presented in this paper is based on a relatively difficult situation, that scenario is nowhere near as stressing as it could be. Consider, for example, the possibility of warfare in the jungle

(e.g., Vietnam and East Timor), the likelihood of warfare in urban centers (e.g., Mogadishu and Chechnya), and the inevitability of warfare in the broader context of complex terrain. While it is difficult to predict with any certainty what the world will look like in the future, these kinds of settings could well be the venue of battle for tomorrow. Remote sensors and precision-guided weapons would be far more limited in these environments than in the 2015 Kosovo scenario presented here.

In this sense, the belief that the applicability of remote fires is expanding may be misplaced. As we move toward an increasing likelihood of warfare in complex terrain, targets may be obscured, exposure times can be much shorter as enemies move from cover to cover, threats may make use of noncombatants as protection, and perhaps, most important, information technology may not work as planned. By leaning toward greater reliance on remote fires, U.S. military planners could be building a modern-day Maginot line.

Thus, the challenge is to ensure that forces are designed with sufficient robustness to meet the increasing public demand for a "cleaner" war, while minimizing collateral damage and maintaining the capability to accomplish military objectives across a wide spectrum of situations. Some combination of remote and organic reconnaissance, surveillance, and target acquisition (RSTA), interservice or joint coordination, and remote and organic ground (indirect and direct) fires will be needed to provide the most responsiveness, effectiveness, and level of coercive and compelling force to best accomplish the wide range of tomorrow's missions.

ENDNOTES

1. Collateral damage may include infrastructure damage, political stability, and even excessive enemy losses. An important example of how such factors can influence tactics can be seen in the changes adopted in strategy and tactics for Desert Storm after the Al Firdos bunker incident in Baghdad.

2. Using information from an Interim Brigade Combat Team planning document, unit strength is just under 3,900 personnel and unit weight is estimated to be 13,000 short tons. Under similar operating assumptions (resupply, maintenance, etc.), an armor brigade would weigh approximately 28,000 short tons; an airborne brigade would weigh approximately 7,000 short tons.

3. Personal communication with COL(P) Rick Lynch, first commander of the digitized brigade.

4. High-resolution simulation involved use of a JANUS-based suite of simulations. For more information on this, see Appendix B of J. Matsumura et al., *Lightning Over Water: Sharpening America's Light Forces for Rapid Reaction Missions,* Santa Monica, CA: RAND, MR-1196-A-OSD, 2000.

5. This is taken from RAND research conducted for the Army Science Board in 2000.

6. Here, aircraft were assumed to operate at high altitude; as a result, aircraft platform survivability was assumed to be 100 percent.

7. See *http://www.fas.org/man/dod-101/kosovo_maps.htm* for estimates of Kosovar civilian densities early in the war.

8. These computations are based on weapon effect ranges derived from documented test results. Additional injuries may result from secondary explosions if armor targets are hit. For a more detailed explanation of the methodology used, see Appendix A of J. Matsumura et al., *Exploring Technologies for the Future Combat Systems Program*, Santa Monica, CA: RAND, MR-1332-A, forthcoming.

9. FCS is envisioned to be a network-centric force that involves a new family of vehicles and other integrated assets; our definition of FCS is based on research conducted for the Army Science Board.

10. "Accomplishment of mission" is a judgment call within the JANUS simulation. In this case, the ground force does appear to have enough capability to coerce the enemy to "go to ground." As a result, it would be difficult to continue a campaign of genocide from a defensive position. This is not the case with the application of remote fires as the sole method of engagement. It was not successful in Operation Allied Force by the high-altitude bombing, and there appear to be no programs in place now that will markedly change this for 2015.

11. Advanced operational deployability involves the use of a vertical envelopment concept (in this case, a future tactical rotorcraft (FTR) or aggressive use of C-130J) to bring in the rapidly deploying ground force; doing so converted the offensive operation to a more defensive and raiding operation through aggressive maneuver.

12. In this timeframe, the U.S. ground forces are equipped with advanced sensors and a full range of organic precision weapons. The man-in-the-loop involvement from acquisition to engagement, combined with very short cycle times, made the operation that much more "surgical."

13. Detailed analyses can be found in J. Matsumura et al., *Lightning Over Water: Sharpening America's Light Forces for Rapid Reaction Missions*, Santa Monica, CA: RAND, MR-1196-A/OSD, 2000, and B. Nardulli et al., "Disjointed War: Military Operations in Kosovo, 1999," unpublished RAND research, 2001.

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